

73rd MORSS CD Cover Page

UNCLASSIFIED DISCLOSURE FORM CD Presentation

712CD

For office use only 41205
S & A Division
MCCDC



21-23 June 2005, at US Military Academy, West Point, NY

Please complete this form 712CD as your cover page to your electronic briefing submission to the MORSS CD. Do not fax to the MORS office.

Author Request (To be completed by applicant) - The following author(s) request authority to disclose the following presentation in the MORSS Final Report, for inclusion on the MORSS CD and/or posting on the MORS web site.

Name of Principal Author and all other author(s):

Captain Jonathan Drexler, USMC

Ms. Launa Zaffram

Mr. Cortez Stephens

Principal Author's Organization and address:

Marine Corps Combat Development Command

Studies and Analysis Division

3300 Russell Road

Quantico, VA 22134

Phone: 703-784-6010

Fax: 703-784-3546

Email: launa.jennings@usmc.mil

Original title on 712 A/B: Marine Corps Bulk Liquid Transportation

Revised title: _____

Presented in (input and Bold one): (WG **19**, CG____, Special Session ____, Poster, Demo, or Tutorial):

This presentation is believed to be:
UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 23 JUN 2005		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Bulk Liquid Transportation Options Study				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Marine Corps Combat Development Command Studies and Analysis Division 3300 Russell Road Quantico, VA 22134				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM201946, Military Operations Research Society Symposium (73rd) Held in West Point, NY on 21-23 June 2005 . , The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 33	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Bulk Liquid Transportation Options Study



**Ms. Launa Zaffram
Studies and Analysis Division
Quantico Marine Corps Base
Launa.Jennings@usmc.mil
(703) 784 - 6010**



Agenda



- **Background**
- **Methodology**
- **Baseline Results**
- **Alternatives**
- **Conclusions**



Agenda



- **Background**
- **Methodology**
- **Baseline Results**
- **Alternatives**
- **Conclusions**



Background



Study Sponsor

**Brigadier General Robert E.
Schmidle, Jr.**

**Director, Expeditionary Force
Development Center**

Study Team

Team Lead – Captain Jonathan Drexler, USMC

Team Member – Mr. Cortez Stephens

Team Member – Ms. Lori Taylor

Team Member – Ms. Launa Zaffram



Study Objective



Address the Marine Corps capability to provide bulk fuel and water transportation support for (Marine Air Ground Task Force) MAGTF operations:

- Examine the capability of current equipment and processes to transport bulk fuel and water.
- Examine the capability of other equipment and processes, not currently employed by the Marine Corps, to transport bulk fuel and water.

This brief will focus on the fuel transportation piece of the study.



Agenda

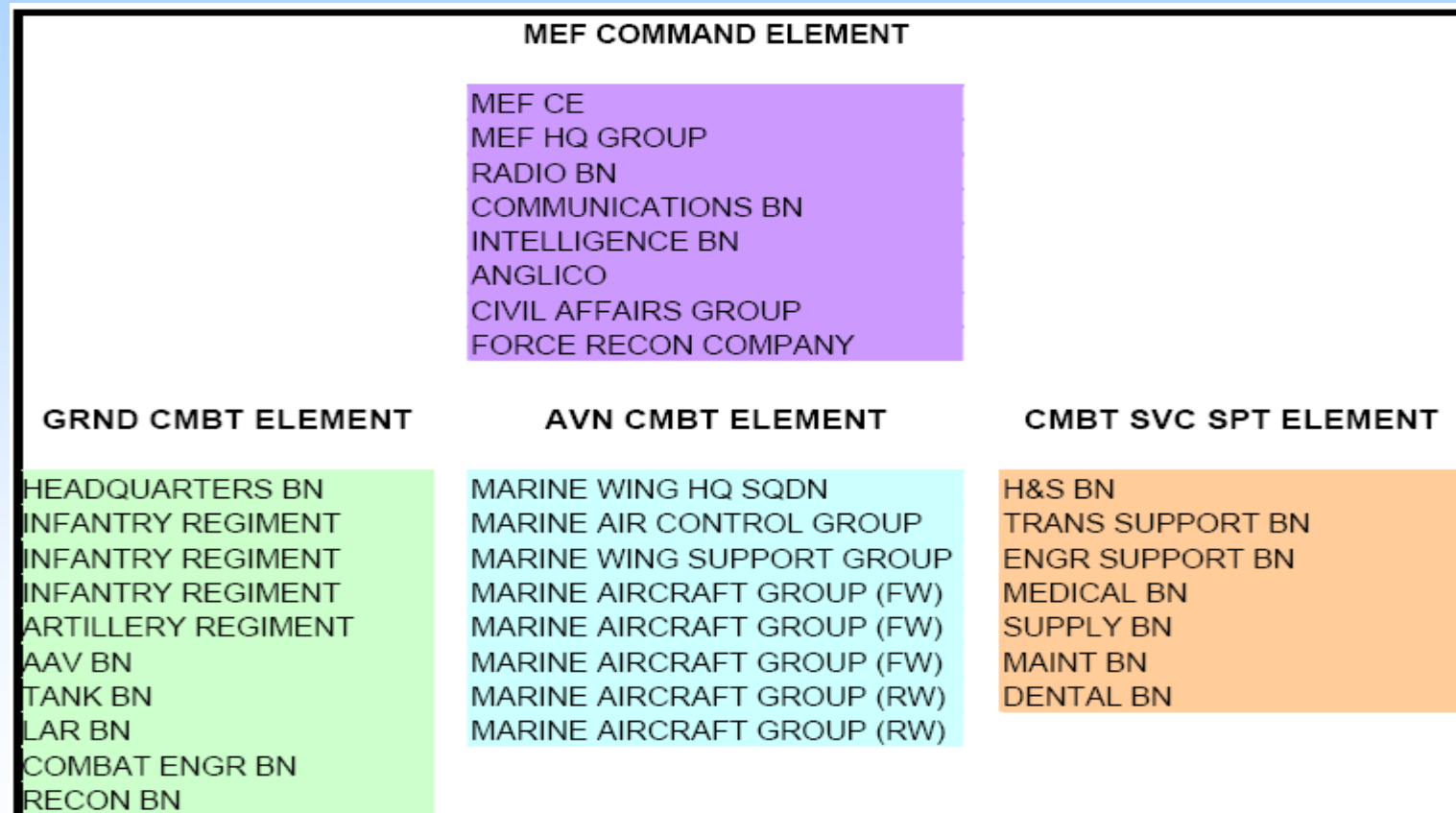


- Background
- **Methodology**
- Baseline Results
- Alternatives
- Conclusions

Methodology - Overview

- Notional Marine Expeditionary Force (MEF)
- Mature theater distribution network
- Demand is calculated using Marine Corps planning factors
- Only ground forces and equipment are taken into account
- Network optimization Excel model uses Solver to optimize truck routes among nodes
- Discrete event simulation Extend model builds on results

Methodology – MEF Organization



Methodology – Operational Context

FCSSA – Forward
Combat Service
Support Area

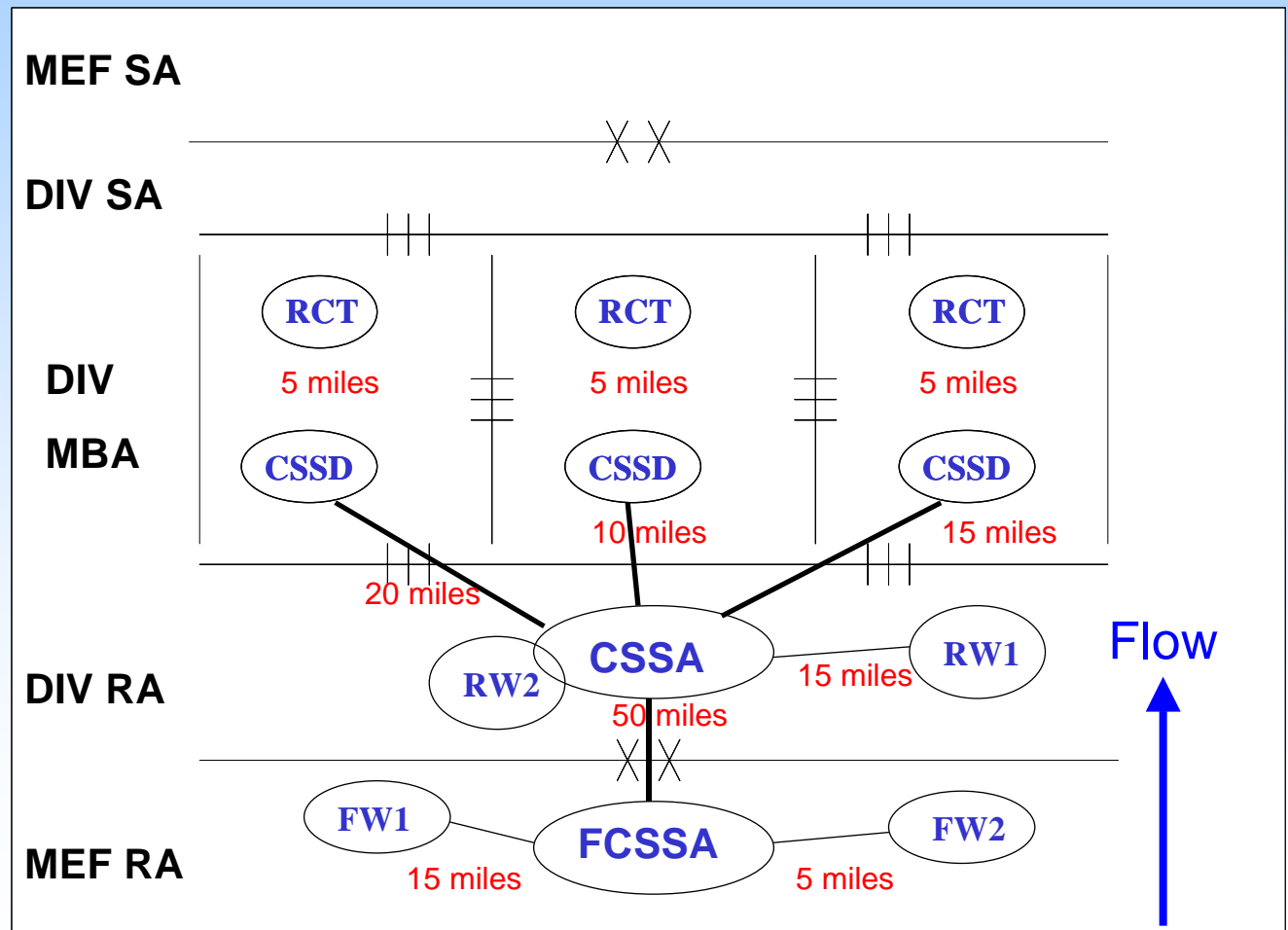
FW – Fixed Wing
(Aircraft)

RW – Rotary Wing
(Aircraft)

CSSA – Combat
Service Support Area

CSSD – Combat
Service Support
Detachment

RCT – Regimental
Combat Team

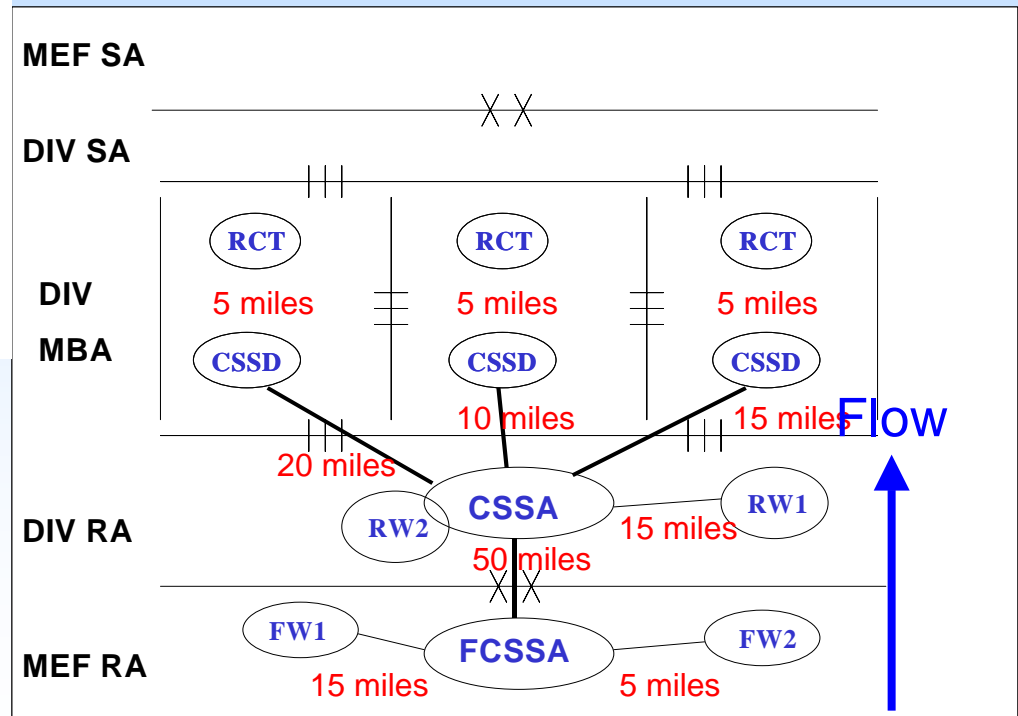


Methodology – Demand

Node	Fuel	Consumption Rate
MEF CP/FCSSA	61,299	Sustained
FW 1	253,121	Sustained
FW 2	159,653	Sustained
RW2/CSSA/DIV CP	357,863	Sustained
RW 1	103,258	Sustained
FARP	15,695	Assault
CSSD 1	19,689	Assault
CSSD 2	19,531	Assault
CSSD 3	19,411	Assault
RCT 1	28,642	Assault
RCT 2	28,695	Assault
RCT 3	28,695	Assault
Total	1,095,552	

Demand is calculated using Marine Corps planning factors

Demand is in gallons.



Methodology – Equipment

- **300** Logistics Vehicle System (LVS)
- **60** Refeulers (20 M970s, 40 Aviation Refueling Capability (ARC) Systems)
- **231** LVS Flatbed Trailers
- **309** Water Trailers (aka: Water Bull)
- **1222** Medium Tactical Vehicle Replacement (MTVR)
- **671** SIXCONs
 - **351** Fuel and **141** Pumps
 - **320** Water and **112** Pumps

Methodology – Excel Model

Network optimization model using Solver

Inputs –

- Equipment Starting Locations
- Distance Between Nodes
- Pump Rates
- % of Equipment Available For Use
- Truck Speed
- Truck Running Time
- Fill Capacity
 - By Percentage
 - By Gallons
- Truck Fuel Usage

Inputs																			
		Node																	
		FCSSA	R/W Air 2	CSSA 1	MEF CF	R/W Air 1	FARP	CSSD 1	CSSD 2	CSSD 3	Div CP	RLT A	RLT B	RLT C					
Trucks		****	****	****	****	****	****	****	****	****	****	****	****	****	****				
	LVS	68	16	107	0	8	2	27	27	27	0	6	6	6					
	Tanker	1	0	23	0	0	0	1	0	0	0	0	0	0					
	MTVR	200	0	164	0	38	0	142	143	143	0	102	103	103					
	ARC	0	0	0	0	10	0	0	0	0	0	0	0	0					
	Army	0	0	0	0	0	0	0	0	0	0	0	0	0					
Trailers		****	****	****	****	****	****	****	****	****	****	****	****	****	****				
	LVS-Trailer	48	0	96	0	4	0	19	19	19	0	6	6	6					
	Tanker-Trailer	0	0	20	0	0	0	0	0	0	0	0	0	0					
SIXCO's		61	0	132	0	8	0	33	30	29	0	14	14	14					
566 gal drums		10	0	22	0	0	0	8	8	8	0	0	0	0					
Demands		61,299	0	357,863	0	103,258	15,695	19,689	19,531	19,411	0	28,642	28,695	28,695					
To - From		Distance		Pump Rates															
FCSSA-CSSA1		50		Static		Non-Static													
				Sixcoons		Tankers													
CSSA-CSSD1		10		300		100		200											
CSSA-CSSD2		20																	
CSSA-CSSD3		15																	
R/W Air 1-FARP		40		% Available															
CSSD1-RLT A		5		FCSSA/CSSA		100%		191											
CSSD2-RLT B		5		Others		100%		109											
CSSD3-RLT C		5		Total		100%		300		100.0%									
Truck Speed (mph) on		40																	
Truck Speed (mph) off		5																	
Running Time (min)		480																	
				Fuel Usage															
Truck		Fuel Usage		Fill to Capacity			90%												
LVS		12.2		SIXCO's			900												
Tanker		13.5		Drums			1500												
Army		13.5		Army			5000												
ARC		13.5		Tankers/ARCs			5000												
MTVR		6.7																	

Methodology – Excel Model

Fictional trucks carrying 5,000 gallons are used as placeholders to quantify the known shortfall in organic Marine Corps capability.

Trucks Used	130.0	8.8%
Shortfall Trucks Used	65.0	33.3%
Remaining Trucks	1343.0	91.2%
Fuel Used	8,502	
Payload Available	19,093	
Payload Used	2,978	15.6%

Node	Supply
CSSA 1	642,708
CSSD 1	56,133
CSSD 2	52,245
CSSD 3	53,460
FARP	17,550
RLT 1	28,674
RLT 2	29,160
RLT 3	29,160
Total	909,090

Outputs –

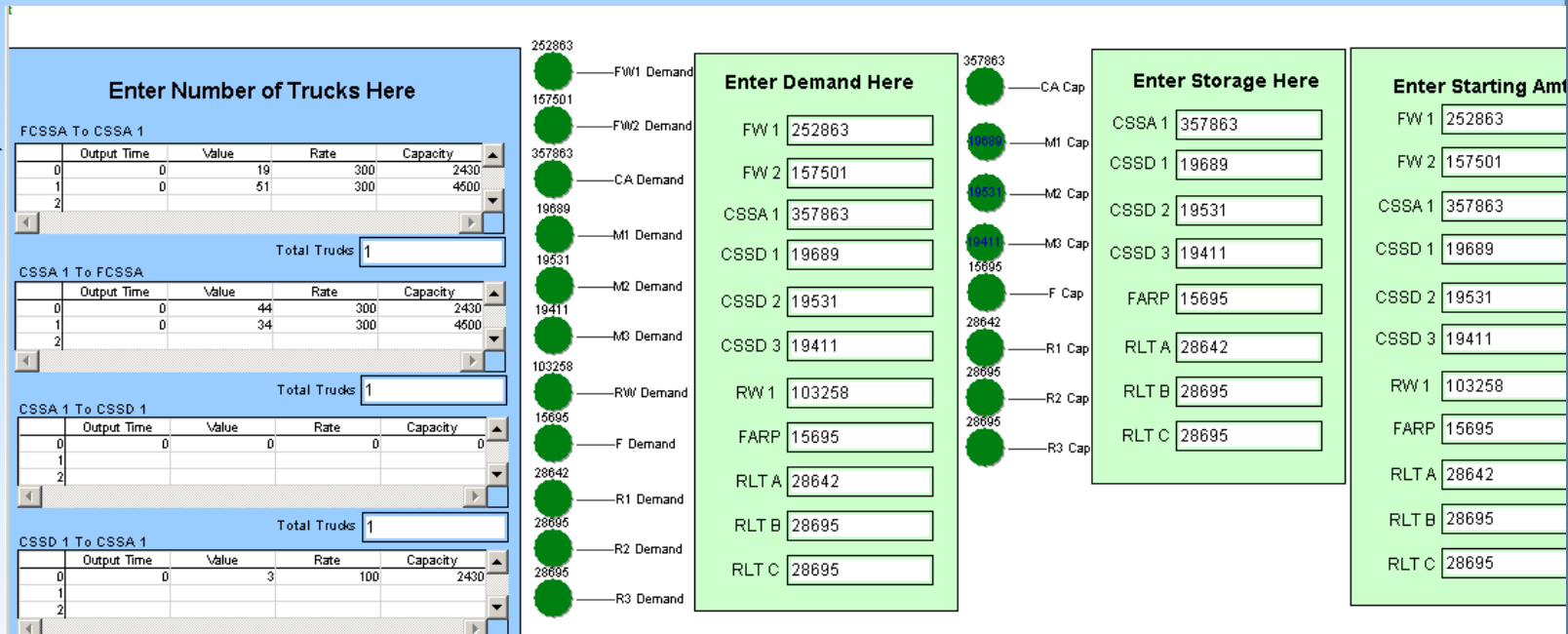
- Trucks used along each arc
- Payload used to transport
- Fuel used to transport
- Remaining trucks
- Supply to each node

The trucks used along each arc are then fed into an Extend discrete event simulation model...

Trucks and Fuel Used	LVS	Tanker	Shortfall	MTVR - Sixcons	MTVR - Drums	ARC	Runs
FCSSA - CSSA 1	19.0	0.0	51.0	0.0	0.0	0.0	1.2
CSSA 1 - FCSSA	44.0	20.0	14.0	0.0	0.0	0.0	1.2
CSSA 1 - CSSD 1	0.0	0.0	0.0	0.0	0.0	0.0	7.7
CSSA 1 - CSSD 2	0.0	0.0	0.0	0.0	0.0	0.0	4.3
CSSA 1 - CSSD 3	0.0	0.0	0.0	0.0	0.0	0.0	5.5
CSSD 1 - CSSA 1	3.0	0.0	0.0	0.0	0.0	0.0	7.7
CSSD 1 - RLT 1	2.0	0.0	0.0	0.0	1.0	0.0	1.8
CSSD 2 - CSSA 1	5.0	0.0	0.0	0.0	0.0	0.0	4.3
CSSD 2 - RLT 2	3.0	0.0	0.0	0.0	0.0	0.0	1.8
CSSD 3 - CSSA 1	4.0	0.0	0.0	0.0	0.0	0.0	5.5
CSSD 3 - RLT 3	4.0	0.0	0.0	0.0	0.0	0.0	1.8
RW Air 1 - FARP	0.0	0.0	0.0	0.0	0.0	3.0	1.3
FARP - RW Air 1	0.0	0.0	0.0	0.0	0.0	0.0	1.3
RLT 1 - CSSD 1	6.0	0.0	0.0	2.0	0.0	0.0	1.8
RLT 2 - CSSD 2	6.0	0.0	0.0	2.0	0.0	0.0	1.8
RLT 3 - CSSD 3	6.0	0.0	0.0	0.0	0.0	0.0	1.8

Methodology – Extend Model

The results of the Excel model are entered in here.



The interface is divided into several sections for data entry:

- Enter Number of Trucks Here:** Contains four tables for truck flow between nodes.

FCSSA To CSSA 1					
	Output Time	Value	Rate	Capacity	
0	0	19	300	2430	
1	0	51	300	4500	
2					

CSSA 1 To FCSSA					
	Output Time	Value	Rate	Capacity	
0	0	44	300	2430	
1	0	34	300	4500	
2					

CSSA 1 To CSSD 1					
	Output Time	Value	Rate	Capacity	
0	0	0	0	0	
1					
2					

CSSD 1 To CSSA 1					
	Output Time	Value	Rate	Capacity	
0	0	3	100	2430	
1					
2					
- Enter Demand Here:** A list of demand nodes with input fields for each.
 - FW 1: 252863
 - FW 2: 157501
 - CSSA 1: 357863
 - CSSD 1: 19689
 - CSSD 2: 19531
 - CSSD 3: 19411
 - RW 1: 103258
 - FARP: 15695
 - RLT A: 28642
 - RLT B: 28695
 - RLT C: 28695
- Enter Storage Here:** A list of storage nodes with input fields for each.
 - CSSA 1: 357863
 - CSSD 1: 19689
 - CSSD 2: 19531
 - CSSD 3: 19411
 - FARP: 15695
 - RLT A: 28642
 - RLT B: 28695
 - RLT C: 28695
- Enter Starting Amount:** A list of starting amount nodes with input fields for each.
 - FW 1: 252863
 - FW 2: 157501
 - CSSA 1: 357863
 - CSSD 1: 19689
 - CSSD 2: 19531
 - CSSD 3: 19411
 - RW 1: 103258
 - FARP: 15695
 - RLT A: 28642
 - RLT B: 28695
 - RLT C: 28695

Inputs:

- Trucks along each arc
- Demand at each node
- Storage at each node
- Starting storage amount

Extend model:

- Discrete event simulation
- Simulation time is 15 days
- Validates the results of the Excel model
- Stochastic variables can be added for sensitivity analysis

Extend Distribution → Network

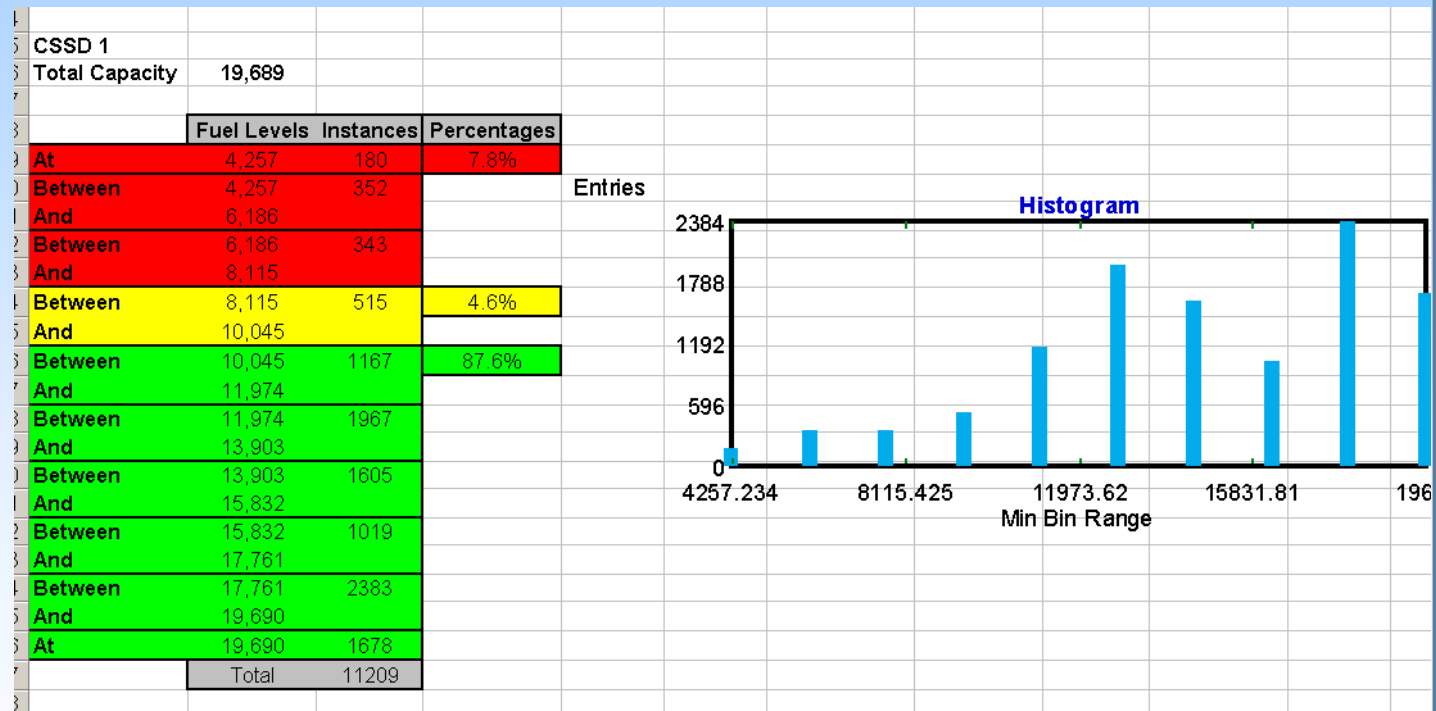


FCSSA Pumps

Methodology – Extend Model

Outputs:

Fuel levels are tracked at each node for all 15 days.



Fuel levels at CSSD 1



Agenda



- Background
- Methodology
- **Baseline Results**
- Alternatives
- Conclusions

Baseline Results - Overall

- Cannot Deliver Required Amount of Fuel
- Captured the Difference in Terms of “Shortfall Trucks”
- Require an Additional 65 Shortfall Trucks
 - Lack the capability to move 292,500 gallons
- MEF Organic Equipment Cannot Support Fuel Requirements
 - Contract, Army, host nation support?
 - Organic capability?

Baseline Results - Sensitivity Analysis

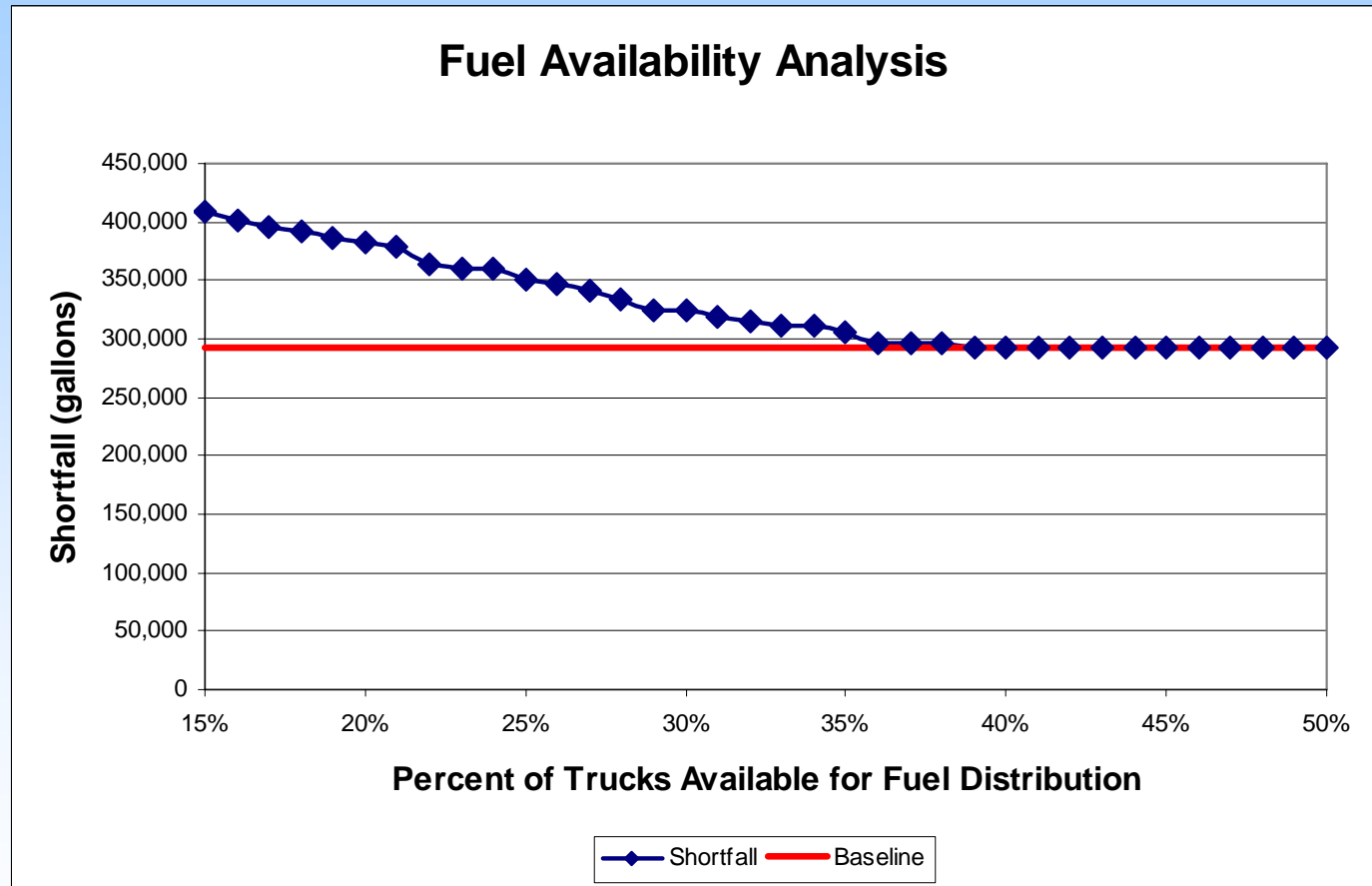
- How a solution changes with slight changes to the parameters
- Show:
 - Useful information
 - Unknown relationships
- Better understanding of current capabilities

Baseline Results - Sensitivity Analysis

Use of ground assets is allowed up to 35%.

We varied that percentage from 15% – 50%.

The shortage is worsened by a lower percentage, but little is gained by an increase.

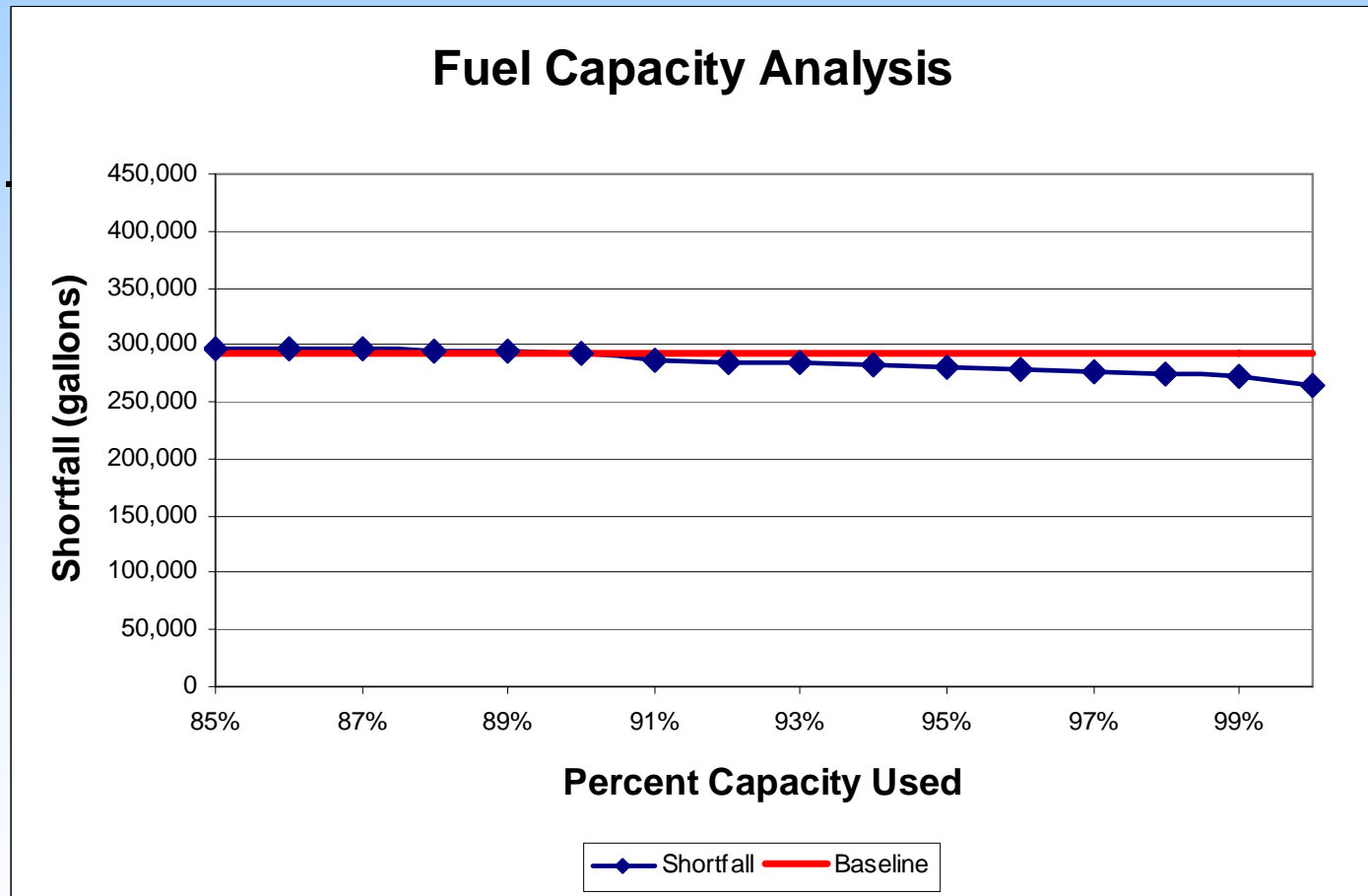


Baseline Results - Sensitivity Analysis

Fill capacity is allowed up to 90%.

We varied that percentage from 85% – 100%.

Little change is observed in shortfall.

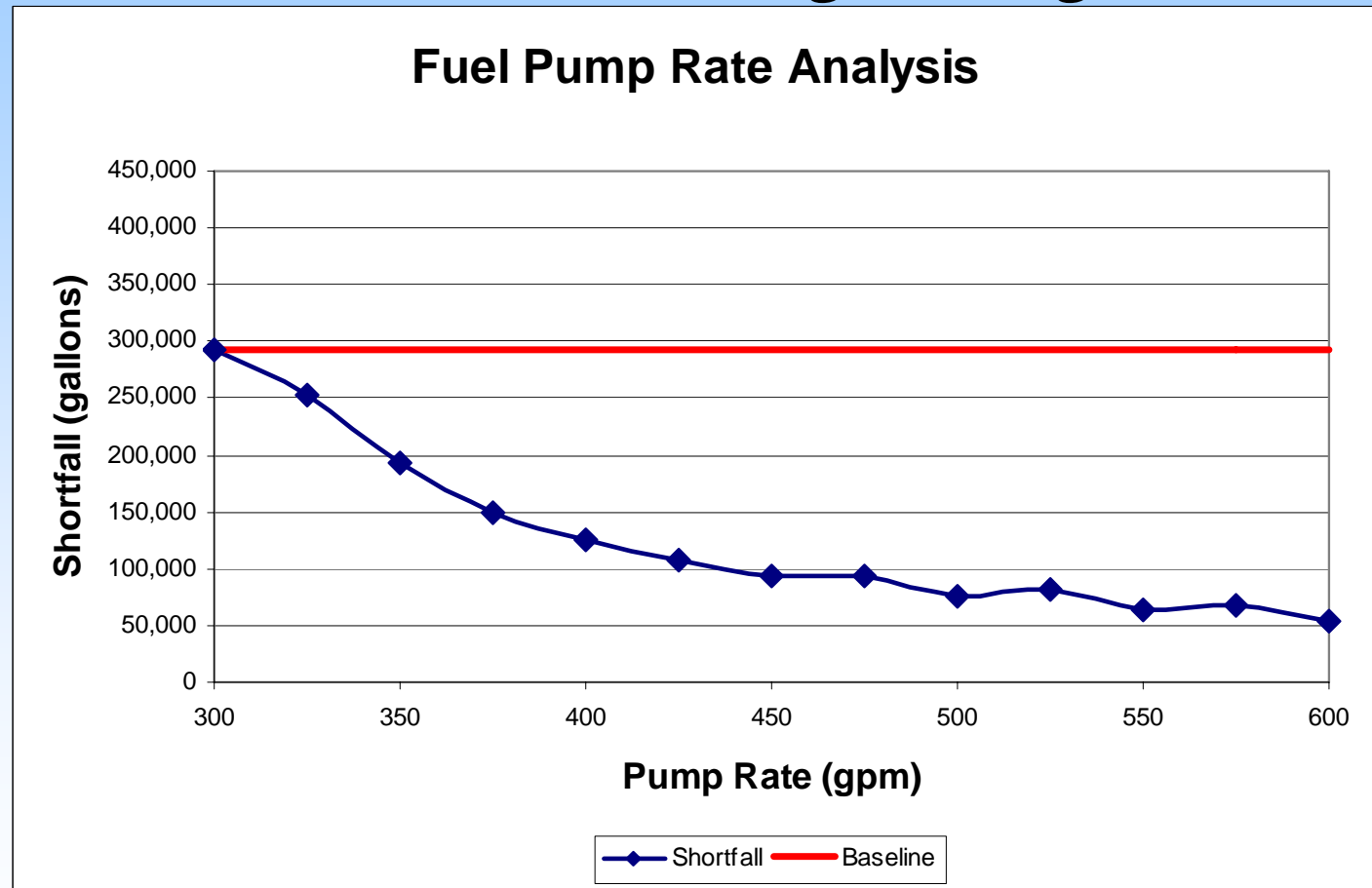


Baseline Results - Sensitivity Analysis

The static pump rate is 300 gpm.

We varied that rate from 300 – 600 gpm.

There appear to be significant gains in small increases in pump rate.





Agenda



- Background
- Methodology
- Baseline Results
- **Alternatives**
- Conclusions

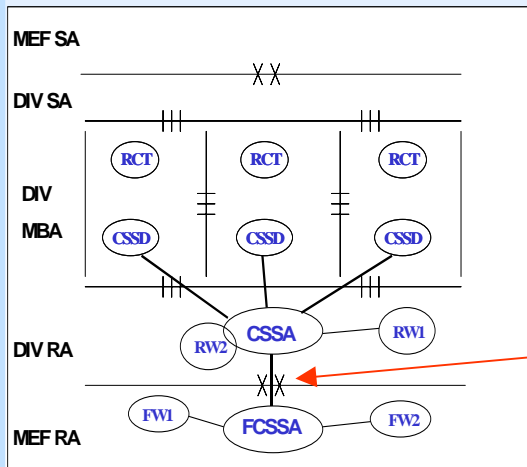
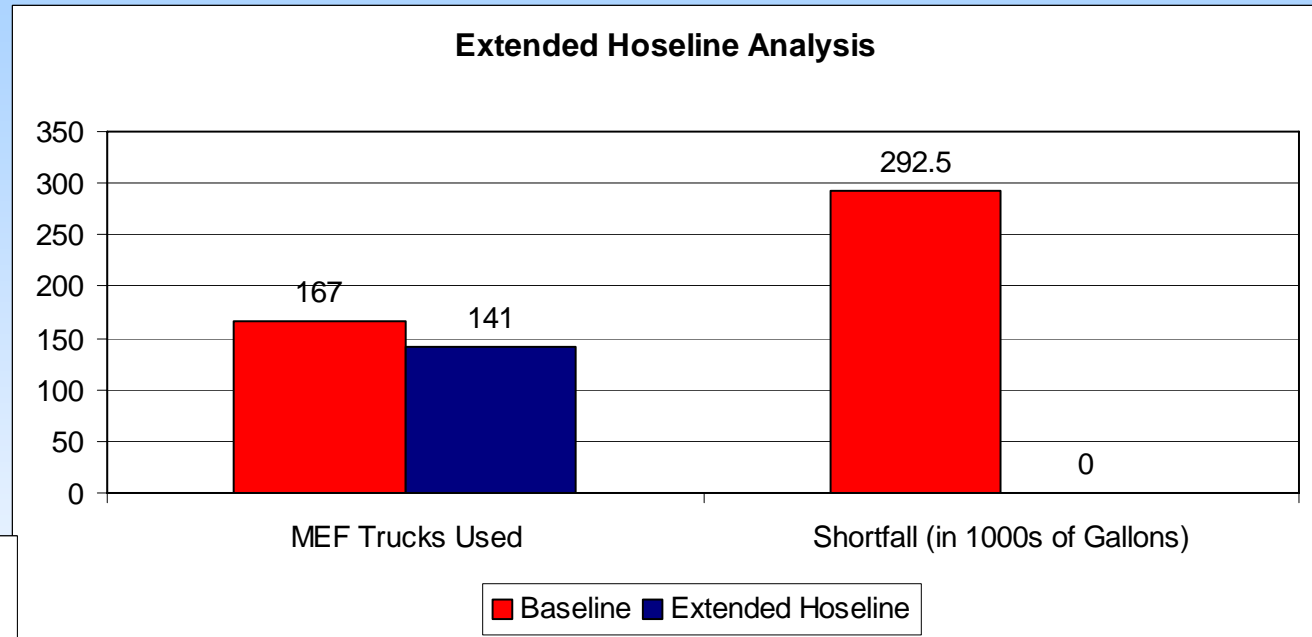
Alternatives

- **Three Alternatives:**
 1. Extended Hoseline
 2. Logistics Vehicle System Replacement (LVSR) and Flatrack Refueling Capability (FRC).
 3. LVSR, FRC and Expeditionary Fueling System (EFS).
- **Each Compared Separately to Baseline Results**

Alternatives - Extended Hoseline

Changes:

- 50 miles of additional hoseline
- From FCSSA to CSSA
- Capacity: 425,000 gallons/day



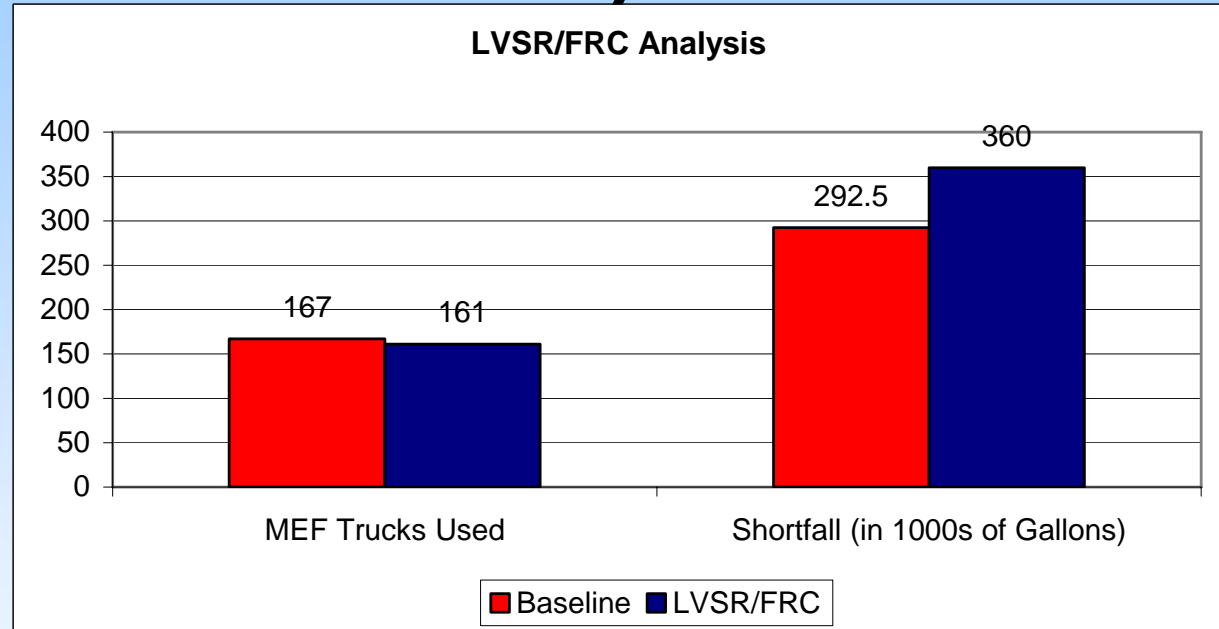
Conclusions:

- Hoseline may not always be possible.
- Whenever possible, it can be very effective.

Alternatives - LVSR/FRC

Changes:

- Replace LVS with LVSR
 - 300 LVS → 263 LVSR
- Replace M970 with FRC
 - 20 M970s → 40 FRCs
 - 2,750 gallon Capacity



Conclusions:

- Fewer LVSRs as compared to LVS
- SIXCONs and FRC now compete for trailer space
 - No longer a dedicated fuel truck

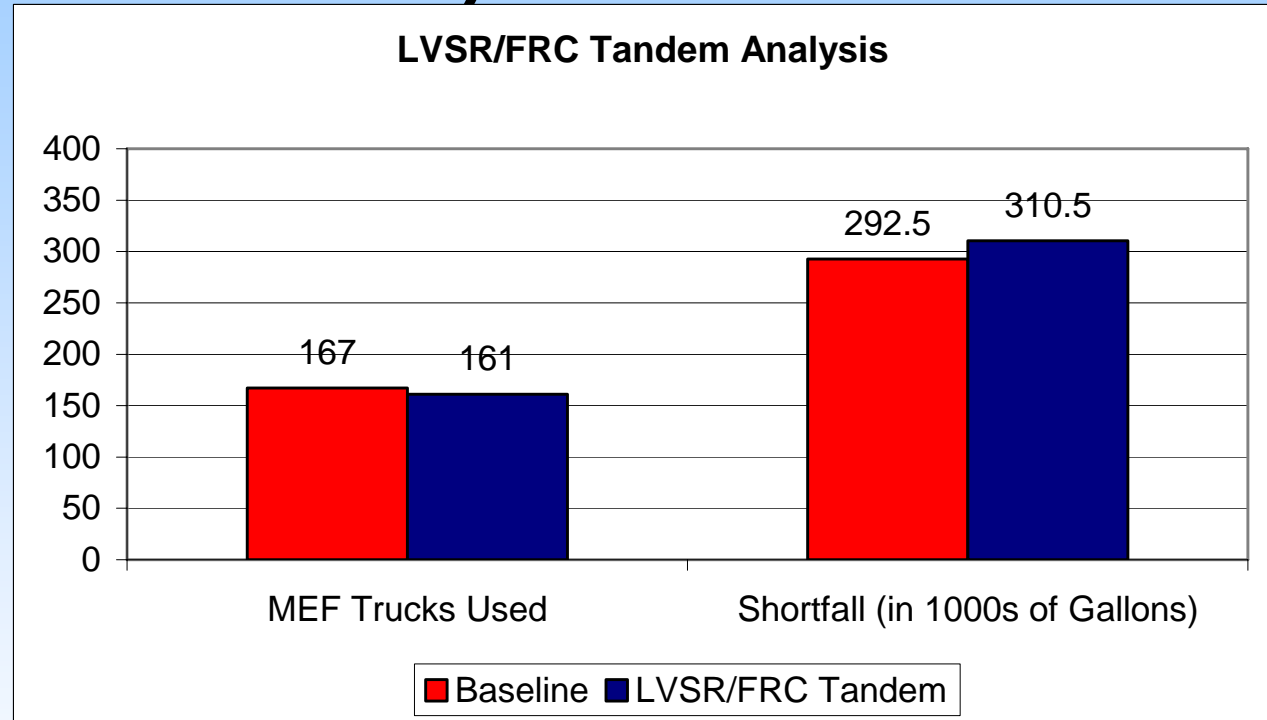
Alternatives - LVSR/FRC Tandem

Changes:

- 45 tandem trailers
 - FCSSA: 15
 - CSSA: 30
- Capability to move twice the fuel
- Engineering issues not taken into account

Conclusions:

- Fewer LVSRs as compared to LVS
- SIXCONs and FRC now compete for trailer space
 - No longer a dedicated fuel truck
- Tandem trailers may help alleviate some shortfall



Alternatives – LVSR/FRC/EFS

Expeditionary Fuel System (EFS):

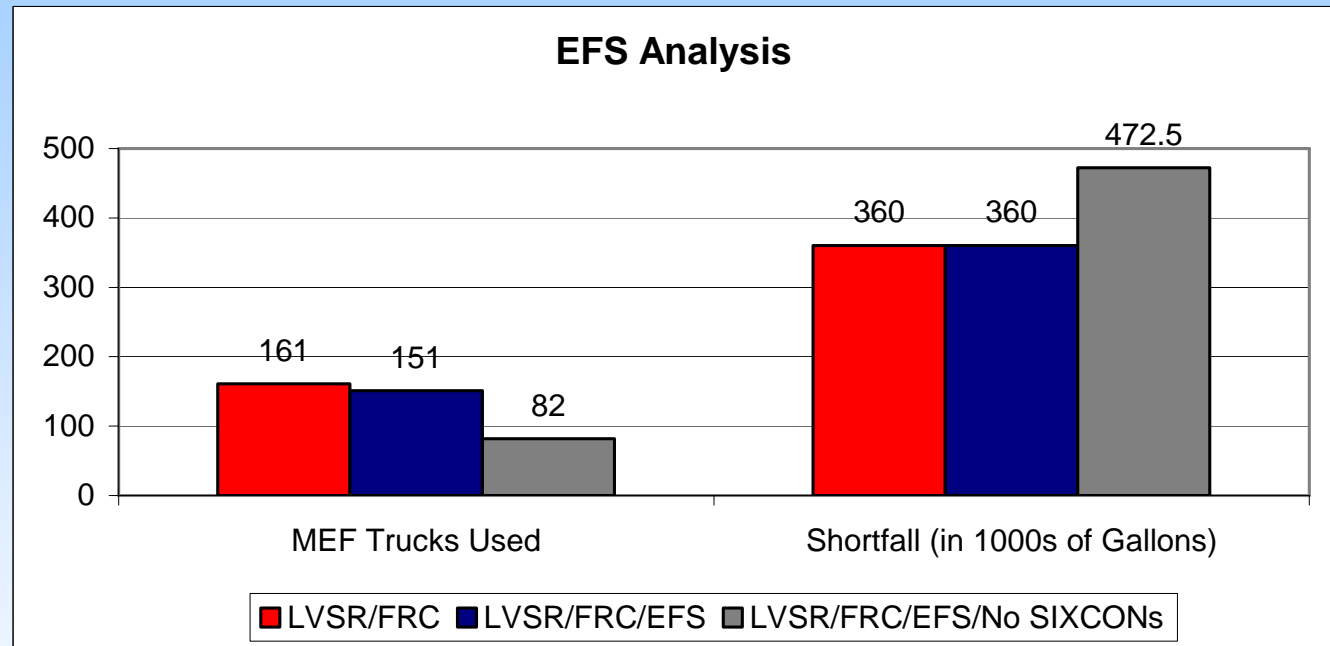
- Modular petroleum distribution system capable of being manhandled, self-pumping, refueling both ground vehicles and aircraft
- Consist of two variations (ORD)
 - Small: 20 – 50 gallons
 - Medium: 150 – 300 gallons
- Multiple, lightweight, collapsible tanks

Version	Small	Medium
Capacity (gal)	28	300
Full Weight	239	2245
Empty Weight	43	145
Length (inches)	47	85
Width (inches)	16	36
Height (inches)	16	36
Stacking Limit	4	2

Alternatives – LVSR/FRC/EFS

Change:

- Add EFS
 - 54 Small: 28 gallons
 - 54 Medium: 300 gallons
- Macro level – not adding a significant capability
- Comparison: No SIXCONs



Conclusion:

- As fielded, the EFS doesn't make a significant difference
- The removal of SIXCONs significantly complicates the situation
 - SIXCONs are an essential part of Bulk Fuel Transportation



Agenda



- **Background**
- **Methodology**
- **Baseline Results**
- **Alternatives**
- **Conclusions**

Conclusions

- Shortfall in transporting bulk fuel is 292,500 gallons per day
- Three ways to address the shortfall in the MEF's current capability:
 - Non-Marine Corps support - host nation or the U.S. Army
 - Obtain additional multi-use systems - LVS/SIXCON combination
 - Obtain single-use systems - ARC or the D1134 Tractor/M970 refueler combination
- Pump rates can have a significant effect on the results
- Extending the battlespace dramatically increases the shortfall
- When possible, extended hoseline can be very effective in reducing the fuel shortfall
- SIXCONs are an integral part of fuel distribution and are the limiting factor in the MEF's ability to satisfy its fuel requirements
- The FRC competes with SIXCONs for space on the LVSR and does not necessarily give the Marine Corps a greater capability
- The EFS shows some benefit when added to current equipment and processes



Questions?

